

# M&S Decision/Role-Behavior Decompositions



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Paul Works, Methods and Research Office/TRAC-HQ

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# Outline

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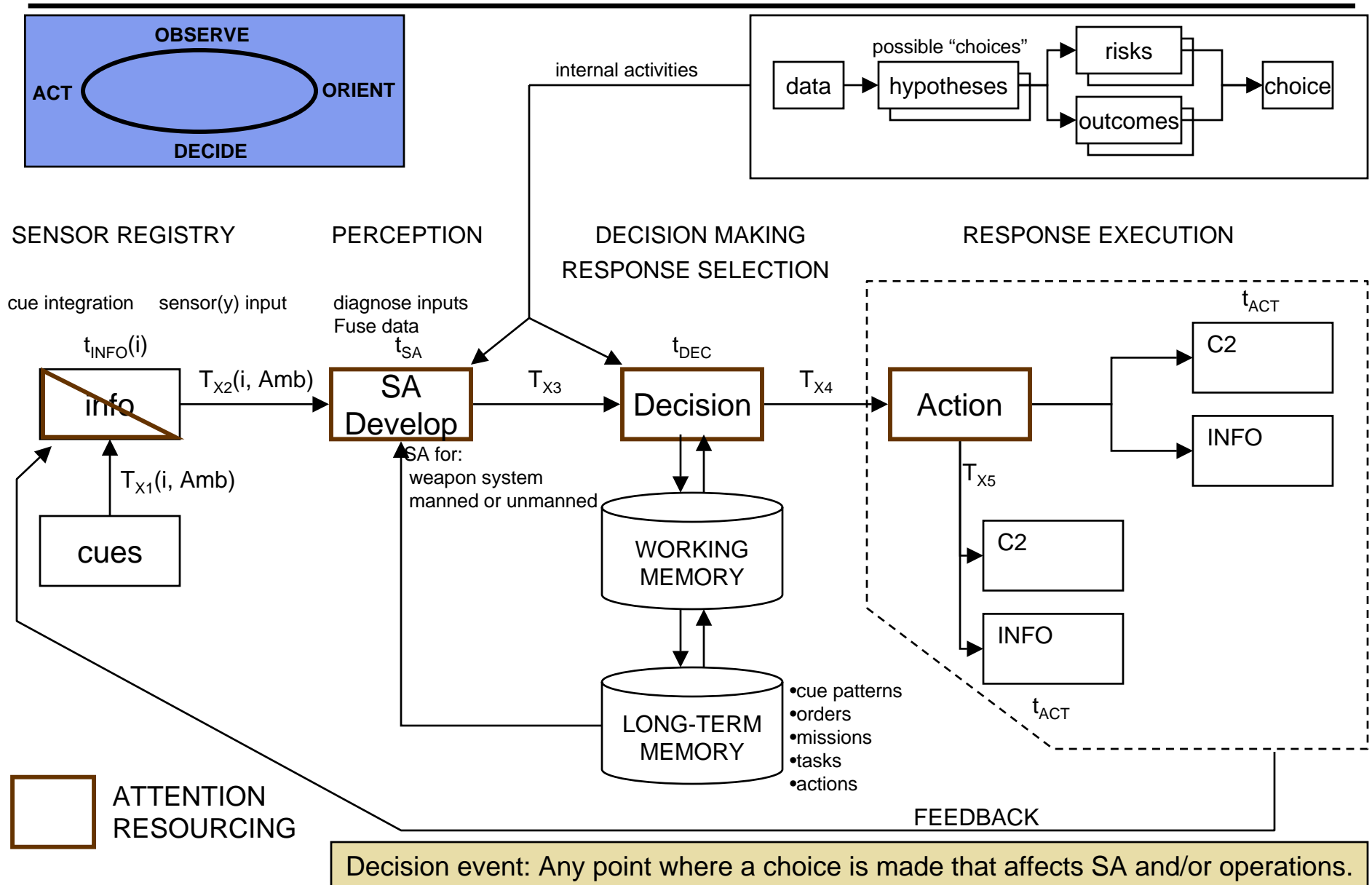
# The Issue

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- Situational awareness (SA) continues to be understood as a key consideration and enabler within both current and future operations.
  - The last several years have seen numerous enhancements in the representations of networks and the physics of data transmission.
- Combat models and simulations (M&S) continue, in most cases, to model “effects-level” representations of SA, decisions, and behaviors.
  - M&S gaps exist in the representation and exploitation of potential analyses possible through more detailed representations of SA, decisions/behaviors.
- Current M&S can be enhanced to more fully explore the benefits, risks, and issues associated with the acquisition and flow of SA data.
  - Modeling discrete decision points and decisions, the latter characterized by behaviors, is one method to alleviate this M&S gap.
- Data to flesh out the modeled decision points and behaviors can be captured by both quantitative and qualitative analyses of wargame activities and events.
- This paper seeks to spur discussion on the topic and presents ongoing efforts led by the TRADOC Analysis Center (TRAC).

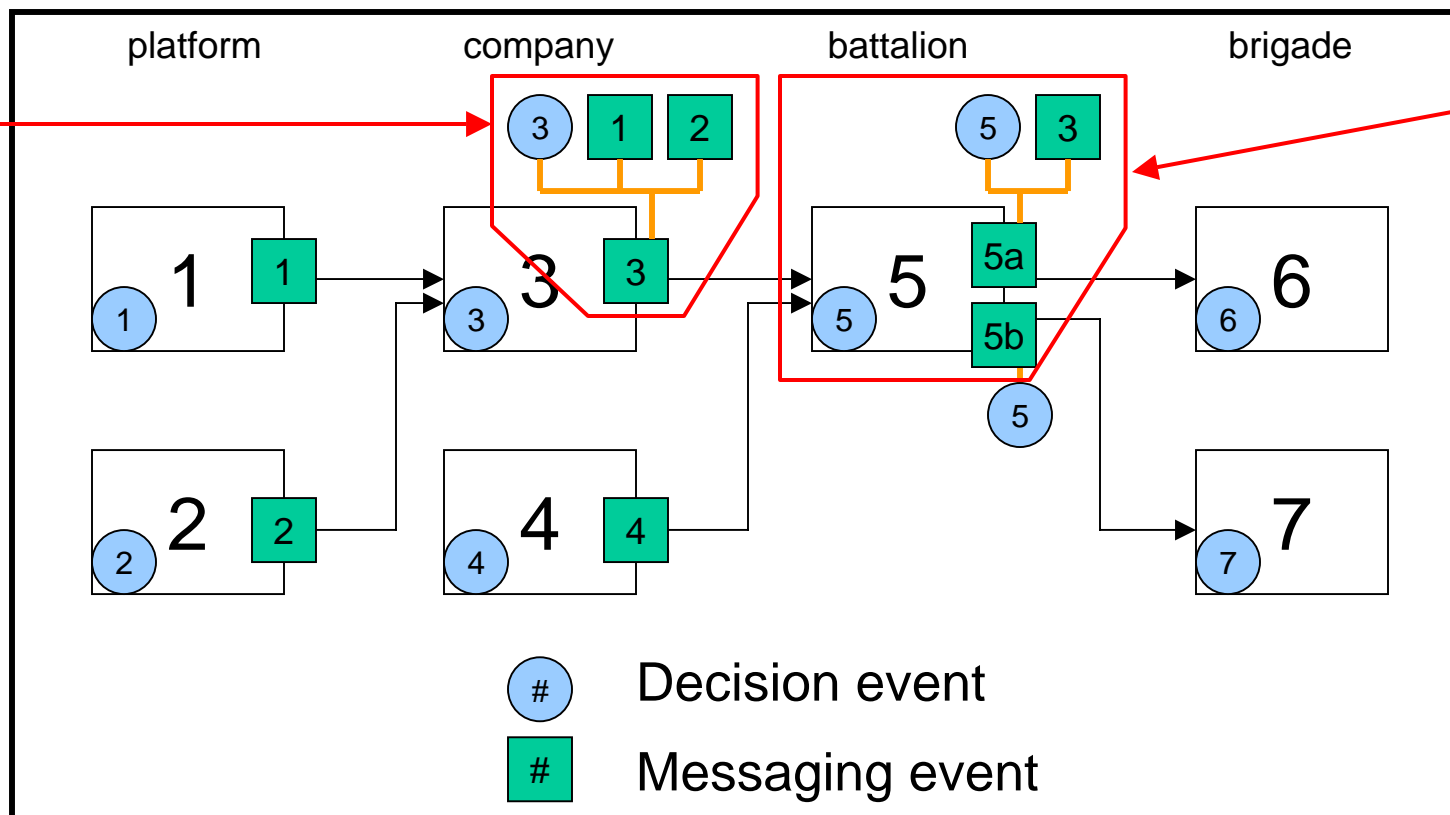
The decomposing and modeling of discrete roles, decisions, and behaviors within M&S will enhance robust analyses of current and future combat operations - critical in providing effective support to key military decisionmakers.

# Situational Awareness Fusion/Decision-Making



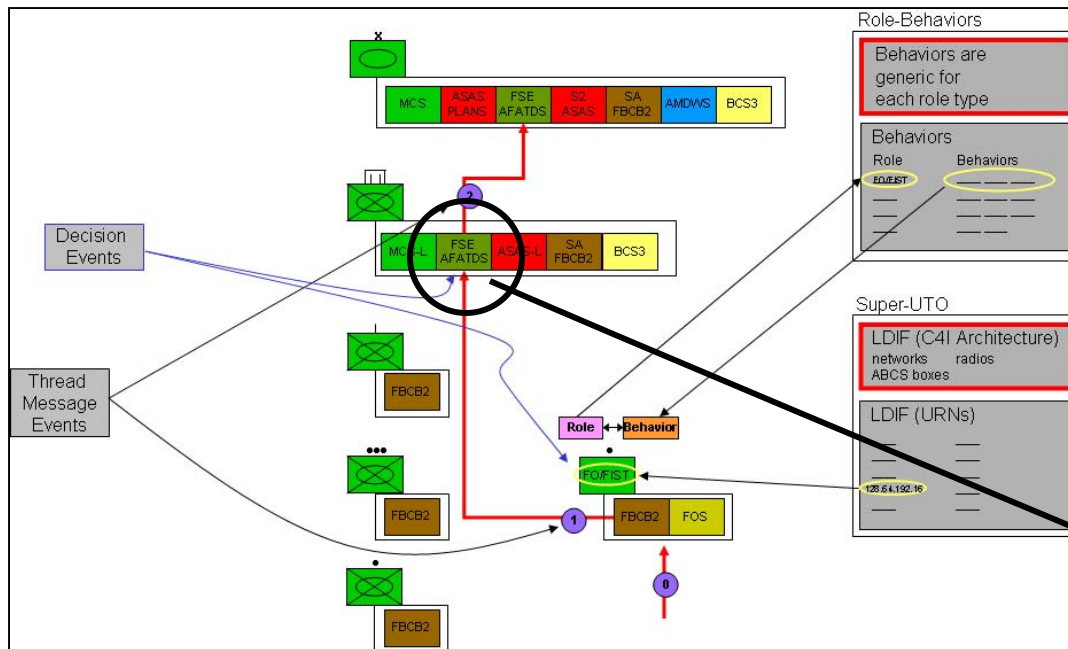
# Characterizing Decision Events

- Multiple inputs typically affect each decision.
- Each decision point/decision may produce one or more outputs.
- Structured data collection within the simulation(s) and by observers is required.



## Characterizing Roles and Behaviors

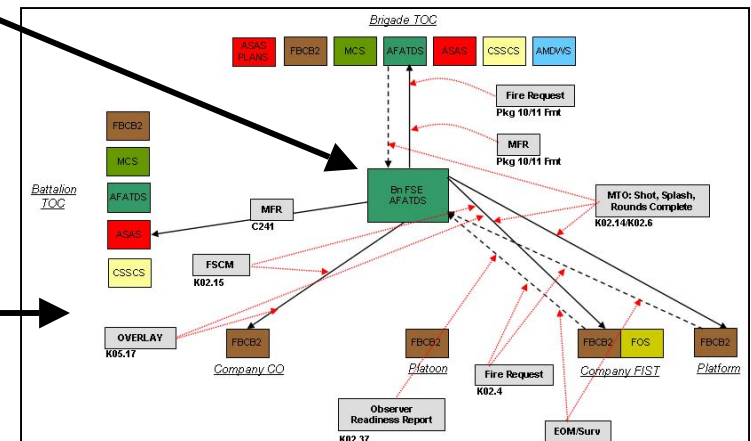
- Role: Personnel/section task assignment.
- Behavior(s): Decisions made by a role based on mission threads, standard operating procedures (SOPs), and current scenario status (role SA, etc.).



## The Solution

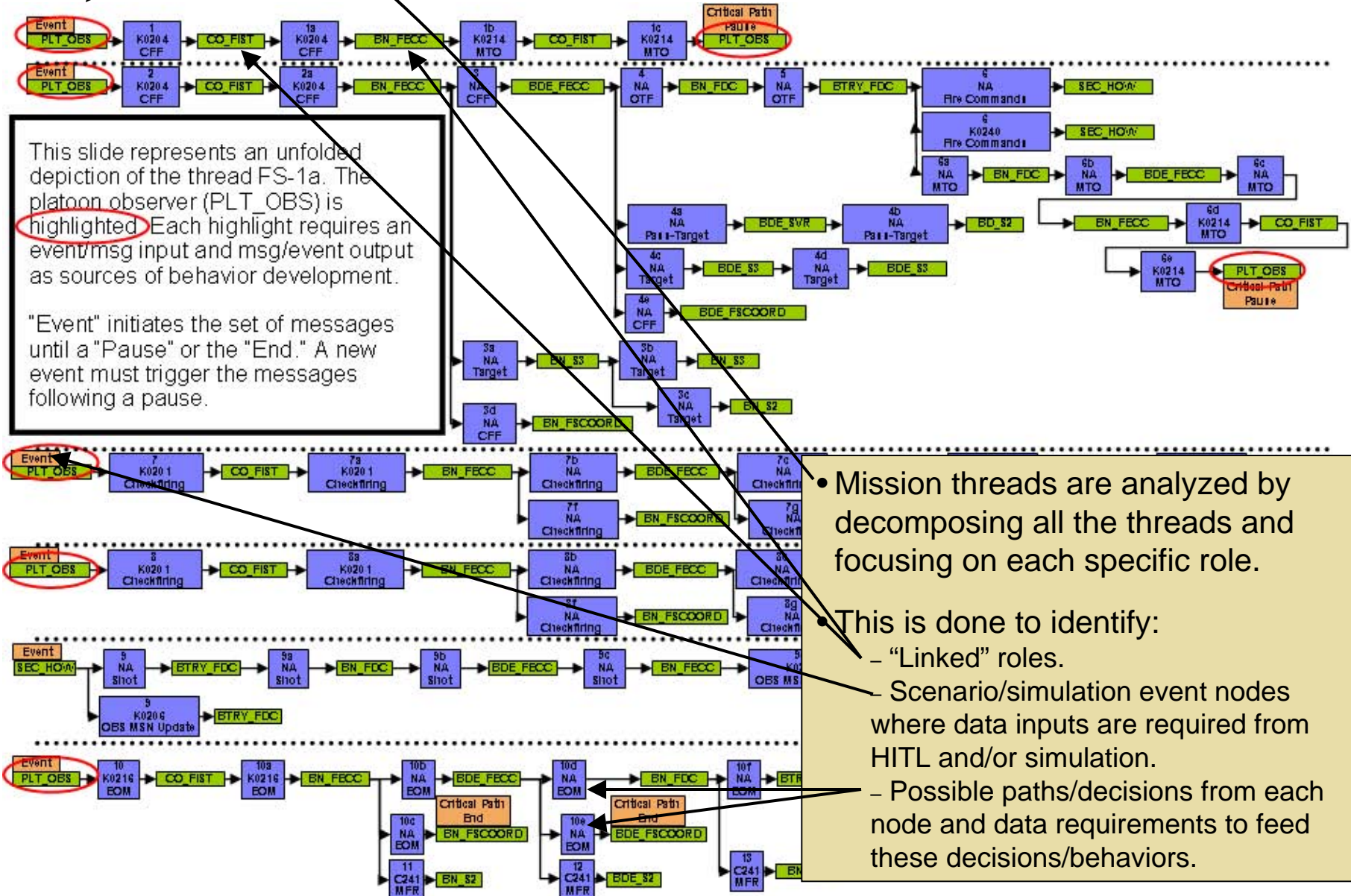
- Develop decomposed, discrete decision points and role-behaviors that emulate both operations and SA.
- Relationships between decision points / “nodes “are flagged.

- Current M&S do not lend themselves well to a dynamic, interactive environment focused on information.
- Doctrine and tactics, techniques, and procedures (TTP) provide the backdrop, but the actual event-flow of decisions is not fully understood or modeled.



# Message Thread Analysis

## FS-1a (Focus PLT\_OBS)



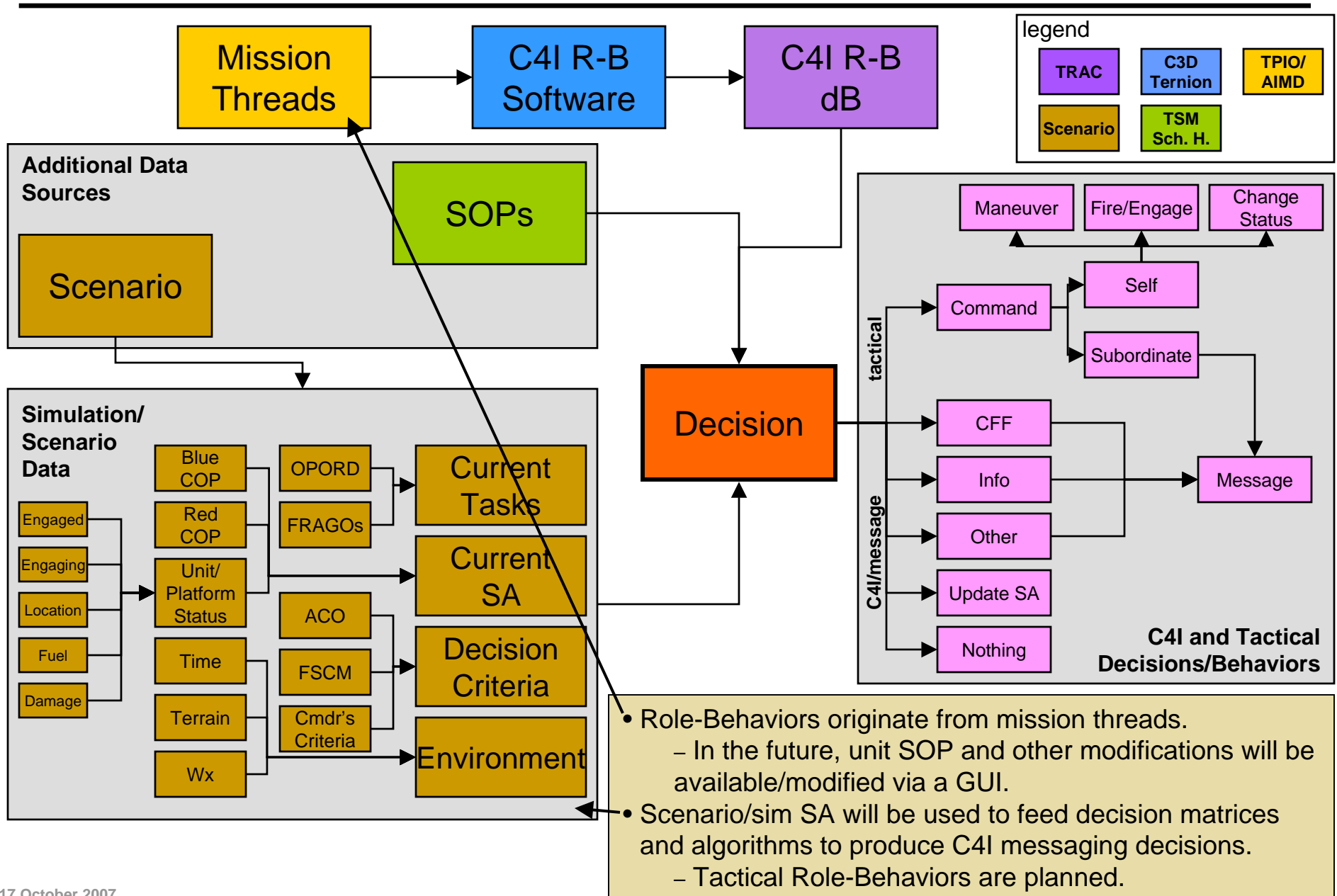


# Ongoing Role-Behavior/Decision Development

- Role-Behaviors.
  - TRAC is leading the development of C4I role-behaviors in support of CERDEC/MATREX, PEO STRI/OOS, TRADOC/BCID, and ATEC/C3 Driver; this Role-Behavior development effort includes:
    - Software to convert TRADOC/SWB mission threads into C4I role-behaviors.
    - Trigger development using TRADOC School House SMEs/data/doctrine; triggers are used to initiate decision events.
  - These C4I role-behaviors will:
    - Portray decision-events and associated messaging within the battlefield environment.
    - Enhance C4I analysis by providing a tagged audit trail of C2 decisions and processes.
  - Following the development of C4I role-behaviors, tactical role-behavior development will be undertaken.
    - Observation of test events, training events, and/or operations will be required.
- Manned vs. Unmanned (MvUM) distinctions.
  - TRAC undertook an analysis to identify the key distinctions between manned and unmanned aircraft.
  - Functional decompositions identified task and physical characteristic distinctions.
  - TTP analyses identified additional behavioral distinctions.
  - Behaviors and other distinctions are being incorporated into TRAC M&S.

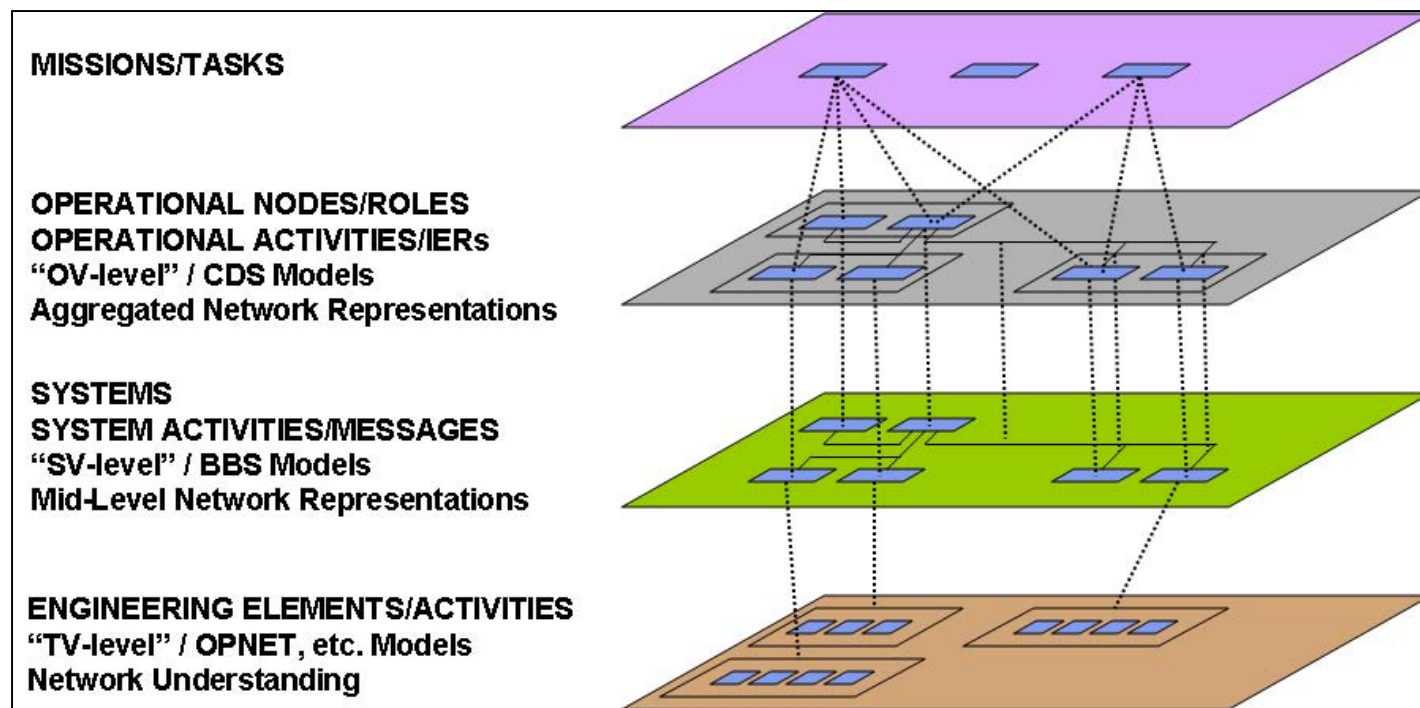
Distinction	Knowledge	Data (Performance/Behaviors)	Algorithms
SA Fusion/ Integration	X	Performance/ Process: X	X
Target Detection/ Acquisition/Examination	X	Performance: X TTP: X	X
Network Reliance/ Communications	X	X	X
Aircraft Control		X	X
Weapons Employment/ Employment C2		X	X
Task Execution	X	Functional: X TTP: X	X
Decision-Making/ Reaction Time	X	X	
Crew Endurance/ Workload	X	X	X
Flight Profile	X	X	X
Environmental Restrictions	X	X	X
Survivability: Acquisition & Engagement Avoidance	X	X	X
Threat OE Considerations	X	X	

# Role-Behavior Development and Execution



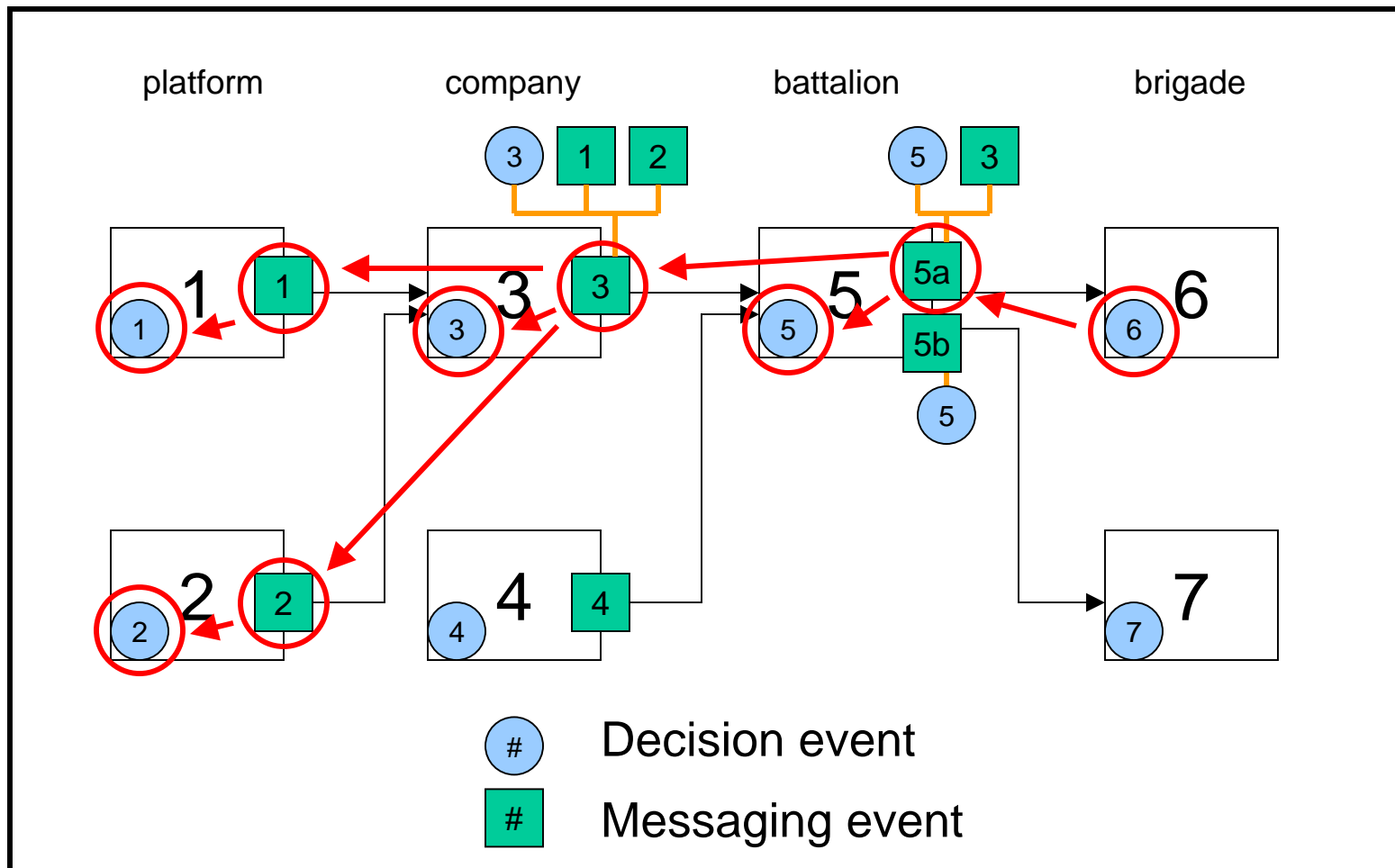
# Decision/Behavior Layered Mapping

- Associated analyses can be more effectively understood by using a tightly coupled analytic approach in representing decisions, roles, and behaviors.
- This involves a “layered” approach to decision, role, and behavior implementation at the various levels of M&S resolution using an adaptive suite of tools.
- The resolution layers will be mapped to one another to produce a sophisticated, logical, and defensible understanding and overarching representation.



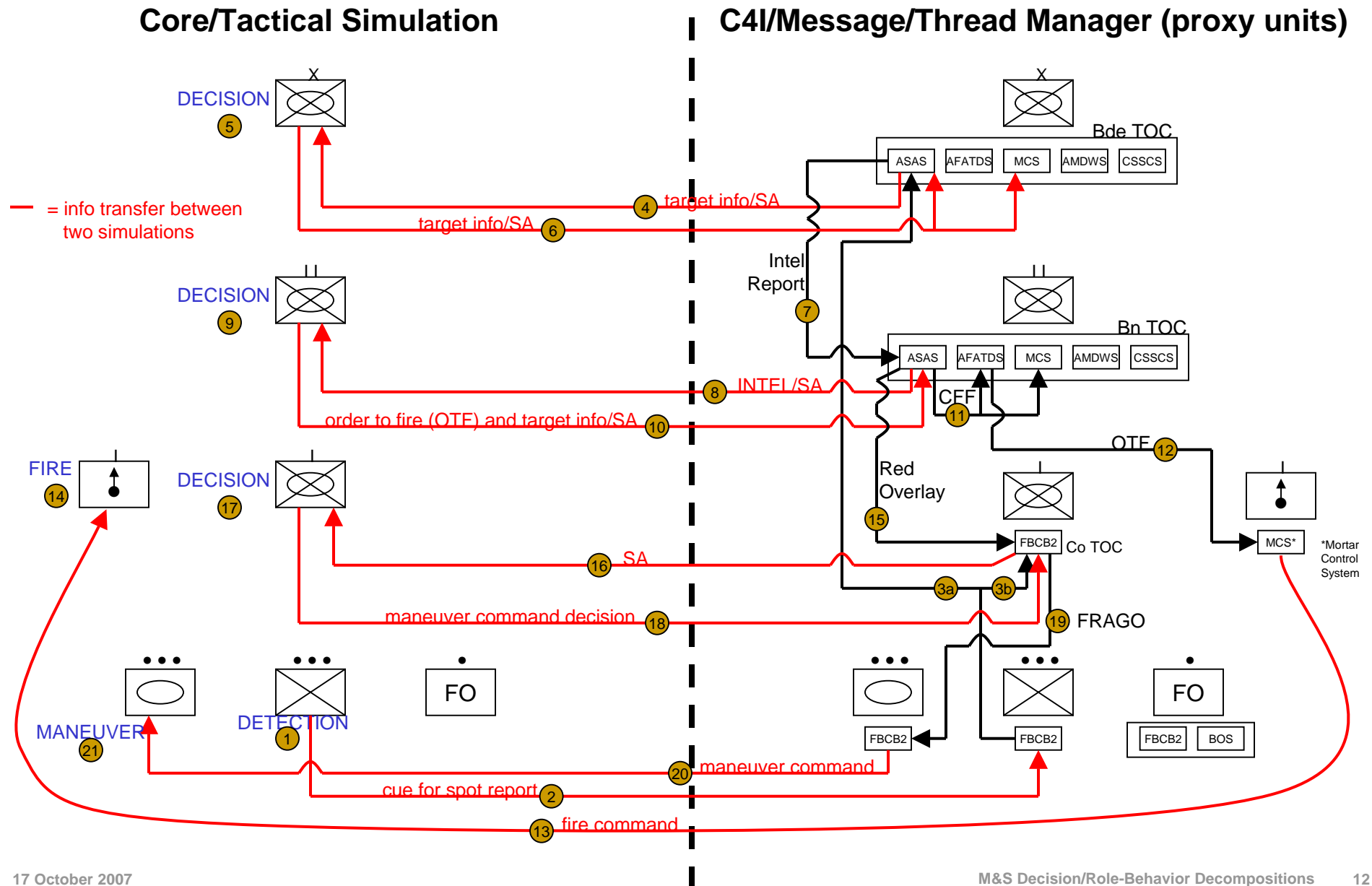
# Traced Decision Events

Highly sophisticated operational decision and C4I analyses will be attainable by assembling, through an flagged audit trail, a series of flagged message and decision events.



- Why did Decision 6 occur?
- Why did Message 5a occur?
- Why did Decision 5 and Message 3 occur?
- Why did Decision 3 and Messages 1 and 2 occur?
- Why did Decisions 1 and 2 occur?

# Tactical-C4I Proxy Architecture



# Qualitative Wargaming Inputs/Data Mining

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- Once the key decision points are identified, the key decisions identified, and the processes modeled analyses can be conducted to fill-in the required data.
  - High-resolution quantitative analyses can be executed by the US Army Research Laboratory (ARL), ATEC, etc.
  - Qualitative data can be captured by analysts observing experiments, test events, training events, and/or operations.
- Data are collated to identify/expound decision and messaging events and specify their associated characteristics.



# Summary

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- It is imperative that current M&S be enhanced to more fully explore the benefits, and risks, in the acquisition and flow of operational and situational awareness data.
- Modeling discrete decision points and decisions/role-behaviors is one method to alleviate this M&S gap.
- Data to flesh out the modeled decision points and behaviors can be captured by both quantitative analyses as well as by qualitative analyses of wargame activities and events.

The decomposing and modeling of discrete roles, decisions, and behaviors within M&S is key to robust analyses of current and future combat operations; such modeling is critical in providing effective support to key military decisionmakers.

# Backups

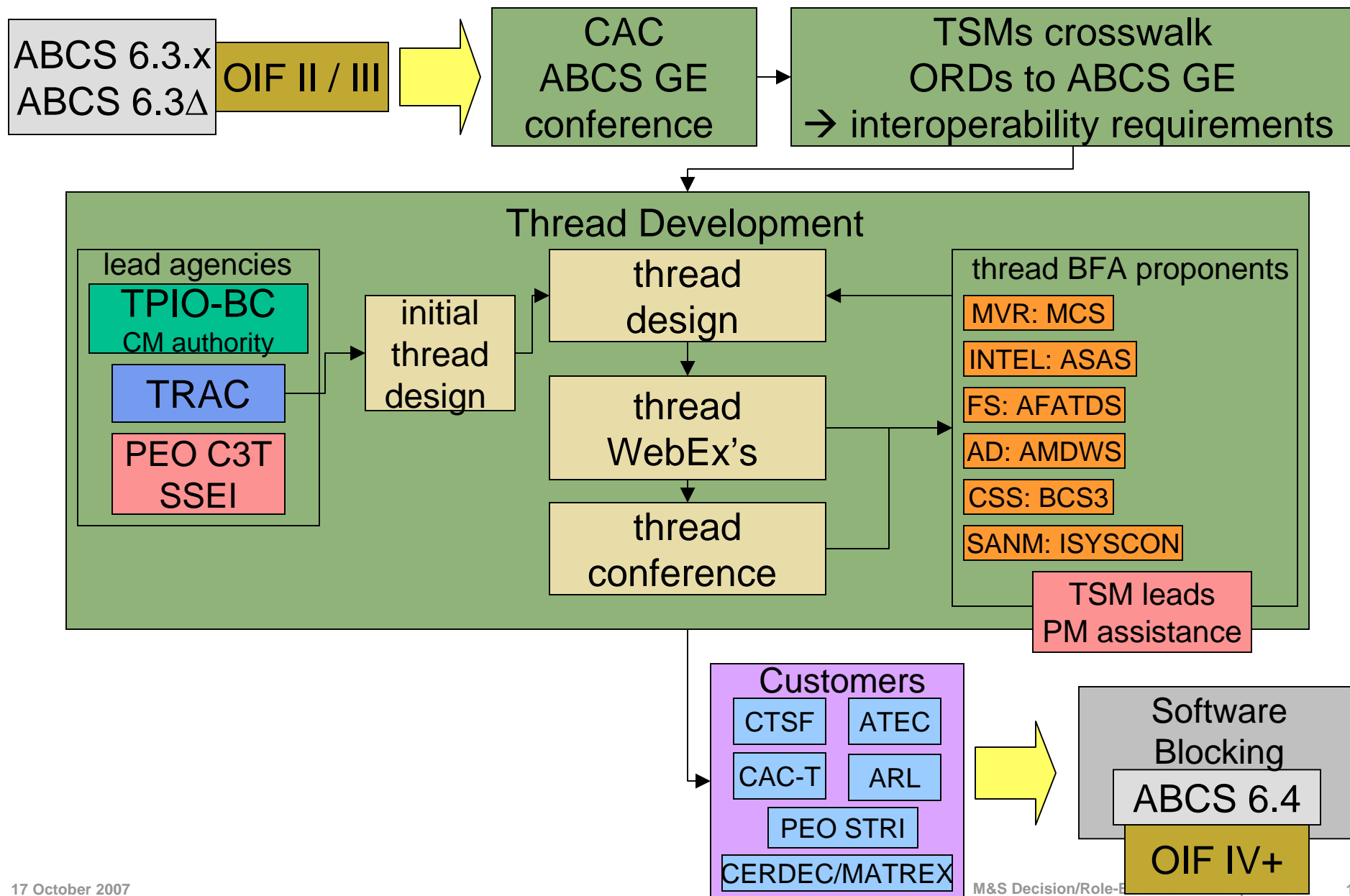
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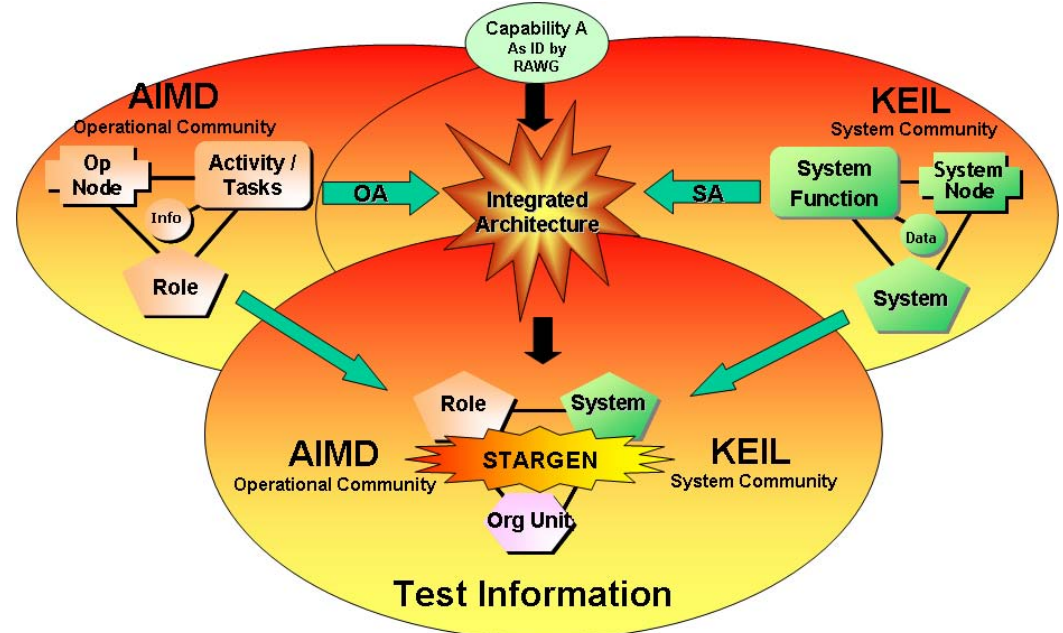
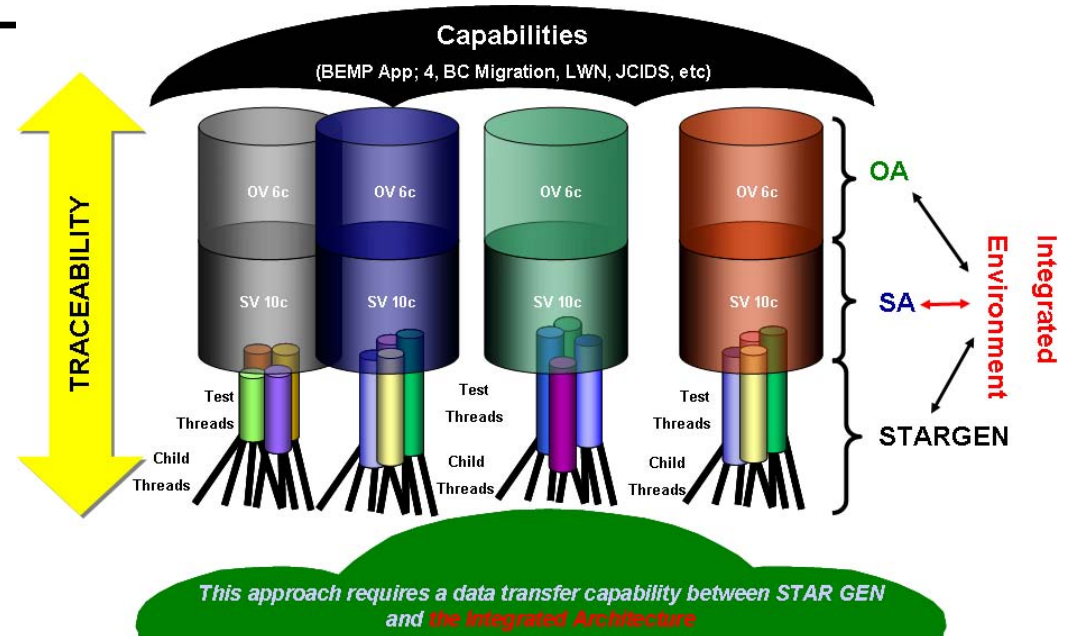
# Mission Thread Development Process

## Software Blocking



# Mission Thread Development (+)

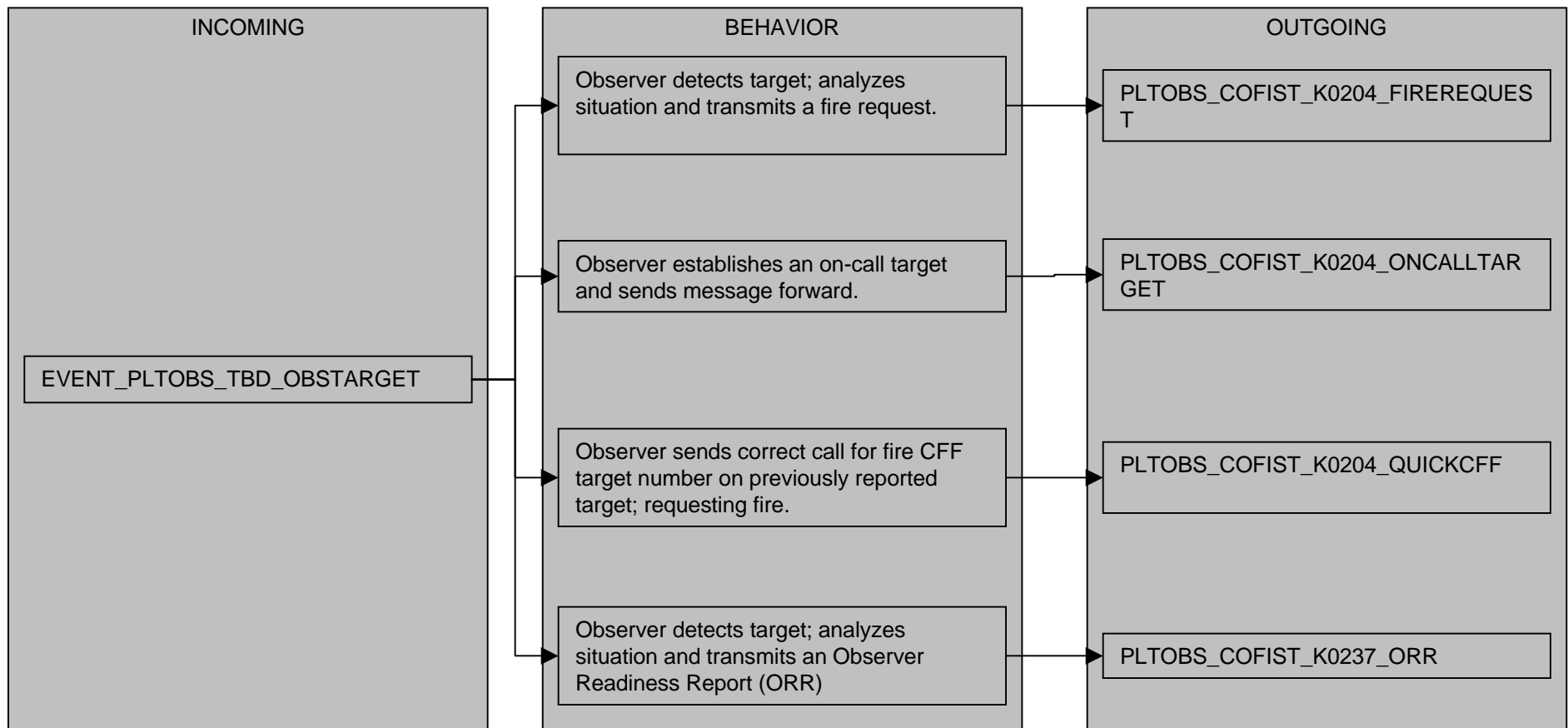
- Linking TPIO-BC mission thread development process to architecture products.
  - AIMD Operational View (OV) products.
  - PEO C3T Knowledge Engineering Integration Laboratory (KEIL) System View (SV) products.
- Will tie mission and task requirements to capabilities and functionality.
  - An initial implementation of the Mission-to-Means Framework (MMF) concept.
- Mission threads will feed analysis, test, and training events.
  - Future COA implementation.



# Sender to Receiver Format Content

## *Observed Event*

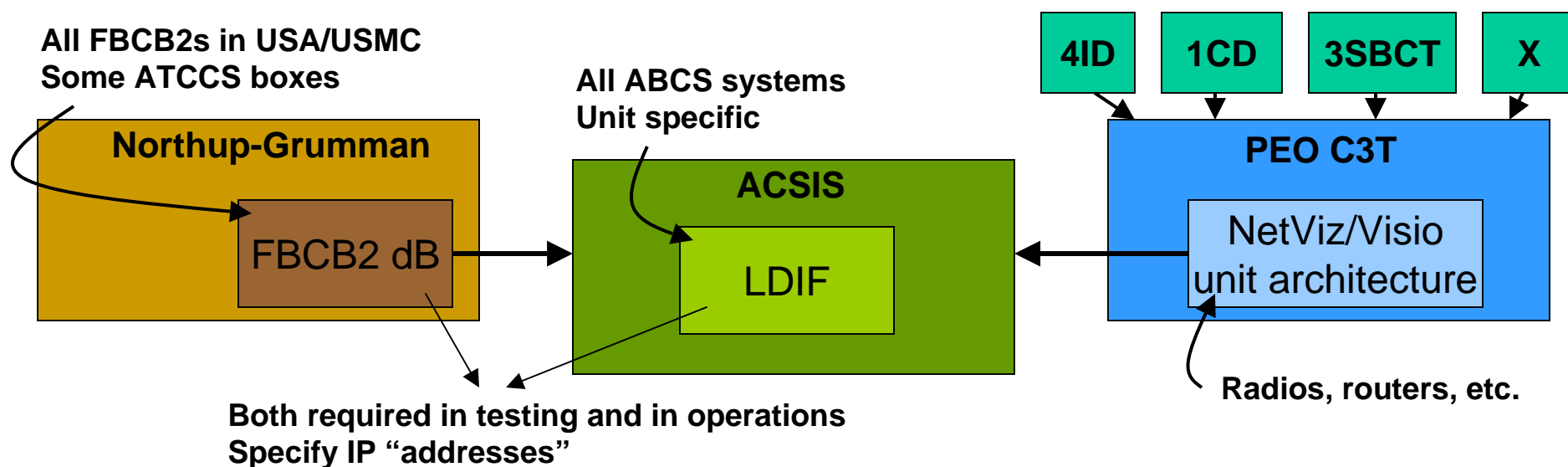
Sender\_Receiver\_Format\_Content



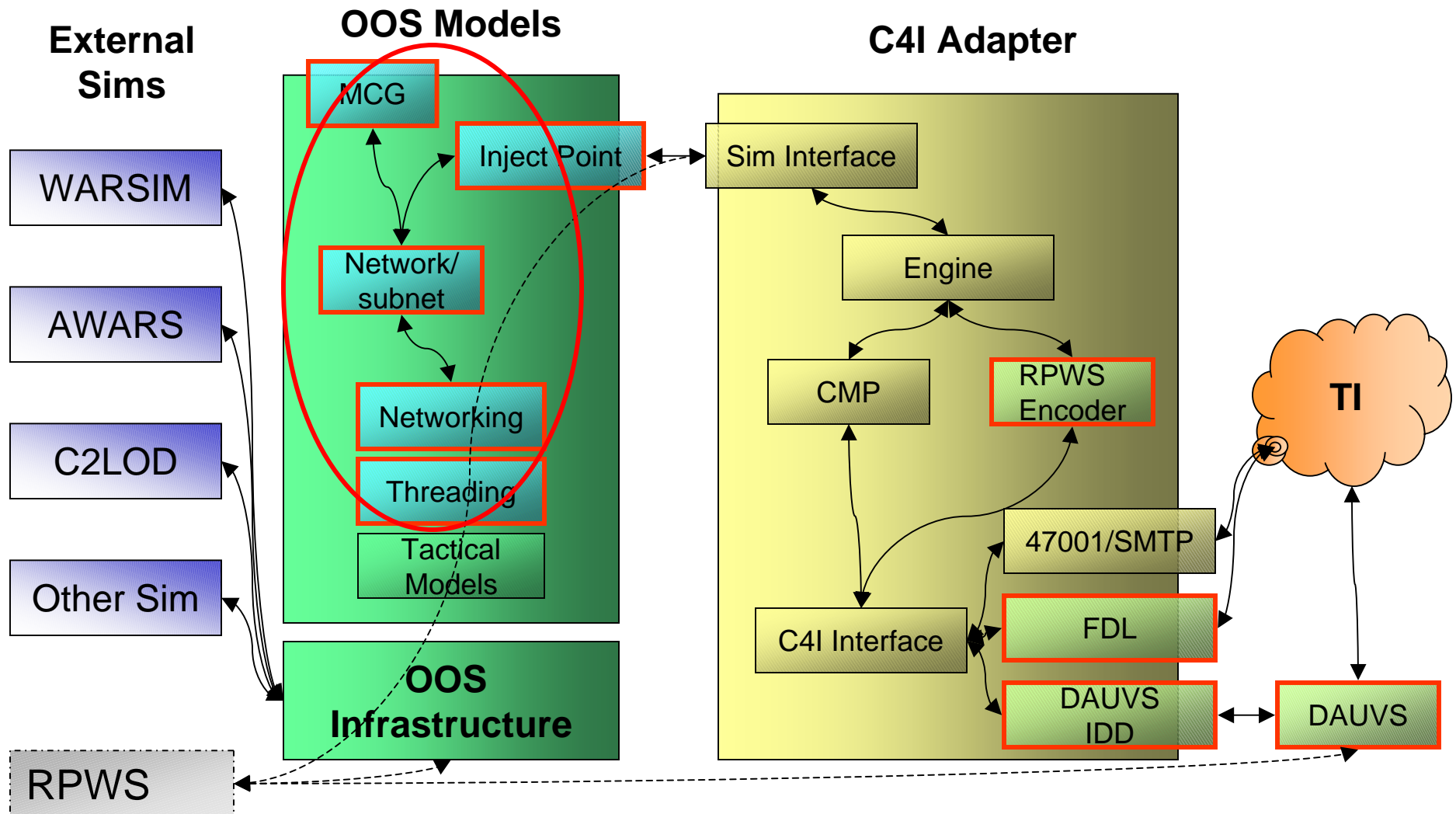
- Messages/data transfers are defined as objects within the software.
  - Scoped by FY06 SWB2 mission threads.
  - Simulation/scenario init events determined by CASTFOREM and TSM/TRADOC School house data.
- Each node is analyzed in detail to determine possible C4I behaviors/decisions.
  - Scoped by FY06 SWB2 mission threads.
  - Vetted by SMEs.

# Generic Address Book Data Products

- **Current force products**
  - Support DT/IT: IAIC graduation event
  - Support OT: OPEVAL wrap-arounds
  - Support training: CAC-T
  - Support experimentation: backwards compatibility for FCS Spin-Outs
- **Future force products**
  - Support analysis: TRAC, LSI/CERDEC(MATREX), etc.
  - Support experimentation: FCS Spin-Outs
  - Support testing: DT/IT and OT, LUTs



# C3D/OOS Sim/Stim Architecture

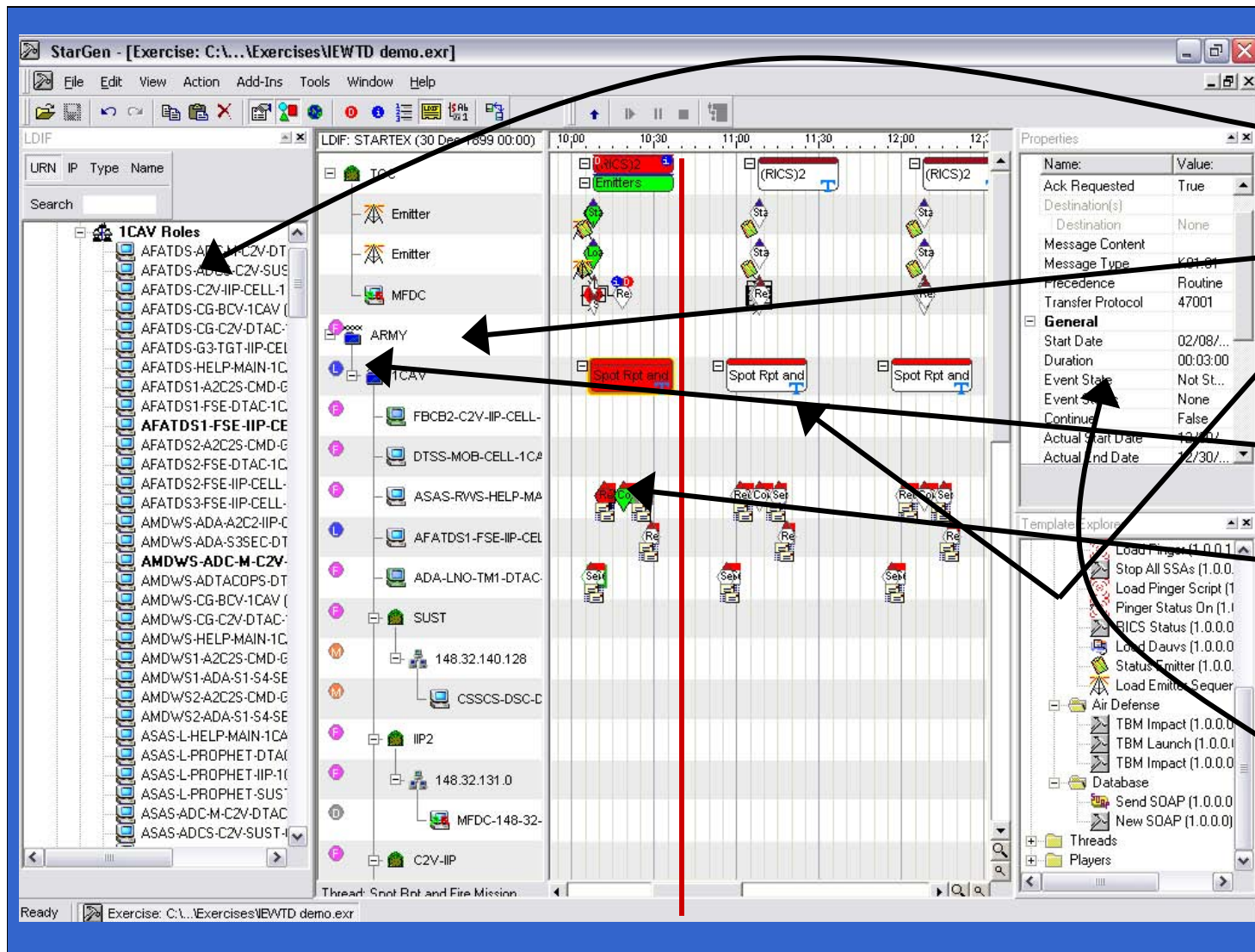


Red outline = C3D/C3D-Associated Components



# StarGen

## Thread Development



- Planning tool becomes the monitoring tool
- Can load organizational databases
- Drag and drop to the player list
- Drag and drop events/templates to the timeline
- Specify players as live or simulated
- Events/templates are color coded as their execution status changes
- Event/message specifics highly controllable
- Status information recorded to the database

# StarGen Grid Entry

StarGen - [Thread Grid]

Edit Action Help

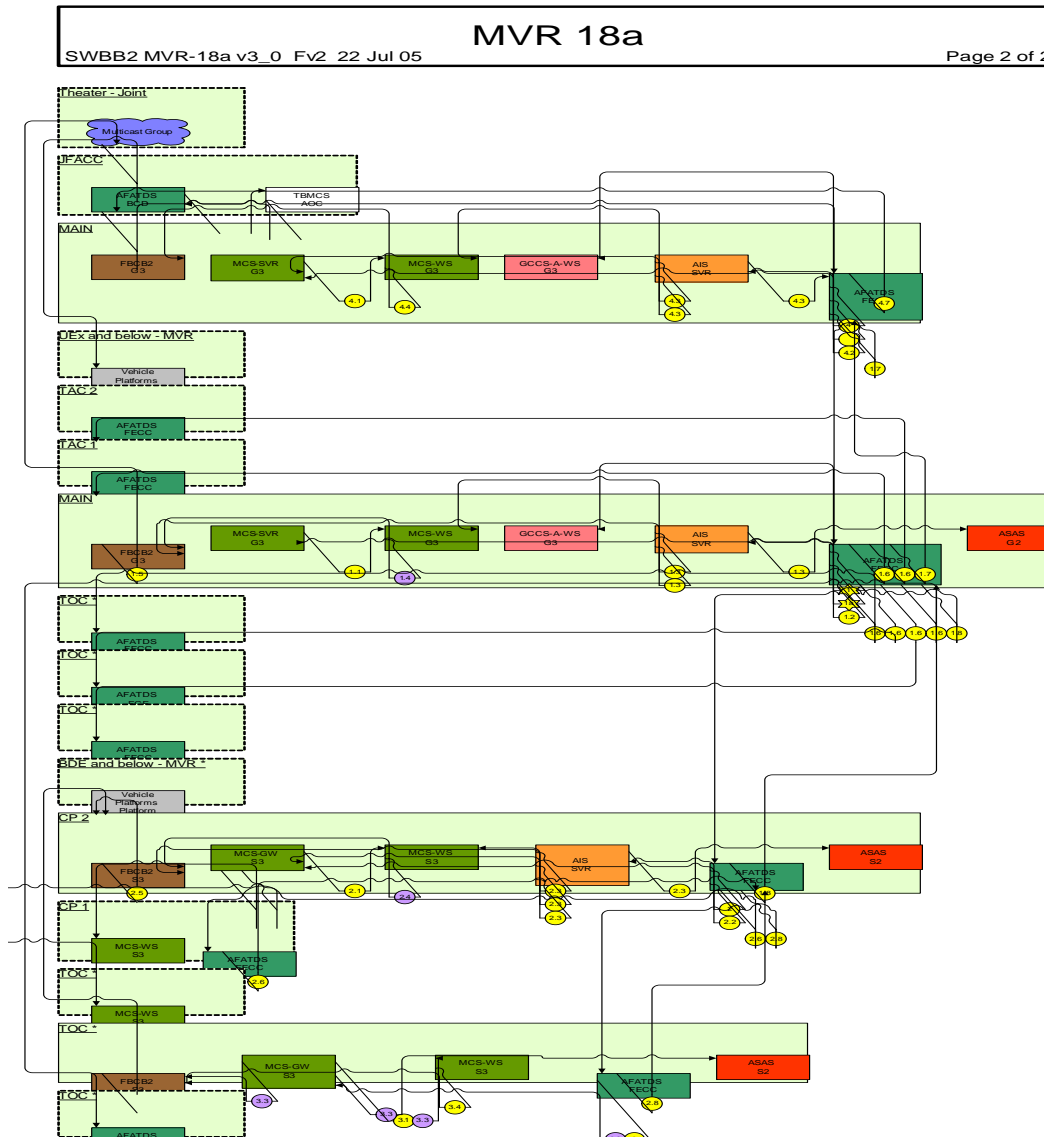
Thread Grid									
Name	Player Name	Start Date	Color	Assumptions	PreConditions	PostCond			
MVR 18a	Theater	4/12/2005 10:27:45		1. AFATDS provides					
Sending Player					Send Event				
System	Echelon	Unit Type	CP Type	Role	Notes	Activity/Task	Comms	Ir	
AFATDS	UEx	None	MAIN	FECC		AFATDS sends Target	LAN	T	
AFATDS	UEx	None	MAIN	FECC		AFATDS sends target list	LAN	T	
MCS-SVR	UEx	None	MAIN	G3	No AFATDS Box in	MCS SVR - NRTS	LAN	T	
AFATDS	UEx	None	MAIN	FECC		AFATDS publishes XML	LAN	P	
AIS	UEx	None	MAIN	SVR	ASAS subscribes to	AIS Server PASS sends	LAN	P	
AIS	UEx	None	MAIN	SVR	ASAS subscribes to	AIS Server PASS sends	LAN	P	
AIS	UEx	None	MAIN	SVR	ASAS subscribes to	AIS Server PASS sends	LAN	P	
MCS-WS	UEx	None	MAIN	G3		MCS WS sends Target	LAN	O	
FBCB2	UEx	None	MAIN	G3		FBCB2 in TOC (has	EPLRS	E	
Multicast Group	Theater	Joint		None		FBCB2 in TOC (has	EPLRS	E	
AFATDS	UEx	None	MAIN	FECC	"No AFATDS Box in	AFATDS exchanges target	WAN	T	
AFATDS	UEx	None	MAIN	FECC	"No AFATDS Box in	AFATDS exchanges target	WAN	T	
AFATDS	UEx	None	MAIN	FECC	"No AFATDS Box in	AFATDS exchanges target	WAN	T	
AFATDS	UEx	None	MAIN	FECC	"No AFATDS Box in	AFATDS exchanges target	WAN	T	
AFATDS	UEx	None	MAIN	FECC	"No AFATDS Box in	AFATDS exchanges target	WAN	T	
AFATDS	UEx	None	MAIN	FECC	"No AFATDS Box in	AFATDS exchanges target	WAN	T	
AFATDS	UEx	None	MAIN	FECC		AFATDS exchanges target	WAN	T	
AFATDS	Corps	MVR	MAIN	FECC		AFATDS exchanges target	WAN	T	
AFATDS	UEx	None	MAIN	FECC		AFATDS exchanges target	WAN	T	
AFATDS	BDE	BCT	CP 2	FECC		AFATDS exchanges target	WAN	T	
AFATDS	BDE	BCT	CP 2	FECC		AFATDS sends Target	LAN	T	
MCS-GW	BDE	BCT	CP 2	S3	1. No AFATDS Box	MCS SVR - NRTS	LAN	T	
MCS-GW	BDE	BCT	CP 2	S3	1. No AFATDS Box	MCS SVR - NRTS	LAN	T	
MCS-GW	BDE	BCT	CP 2	S3	1. No AFATDS Box	MCS SVR - NRTS	LAN	T	

Player Selection: Missing Need To Create X Players Match Confirm Other Cells: Required Non-Star

Ready Exercise: C:\...MVR 18a 18b\SWB2 MVR18a 18b.exr 51 Thread Grid

- Automation Keys:
  - Digitization
  - Ease of use
  - Familiarity
  - Responsiveness to modifications
- "Grid Entry"
  - Excel feel
  - In-house C3D funded
  - Hyperlinked to Visio thread diagram
  - Import/Export from/to Excel

# StarGen Visio/HTML Output

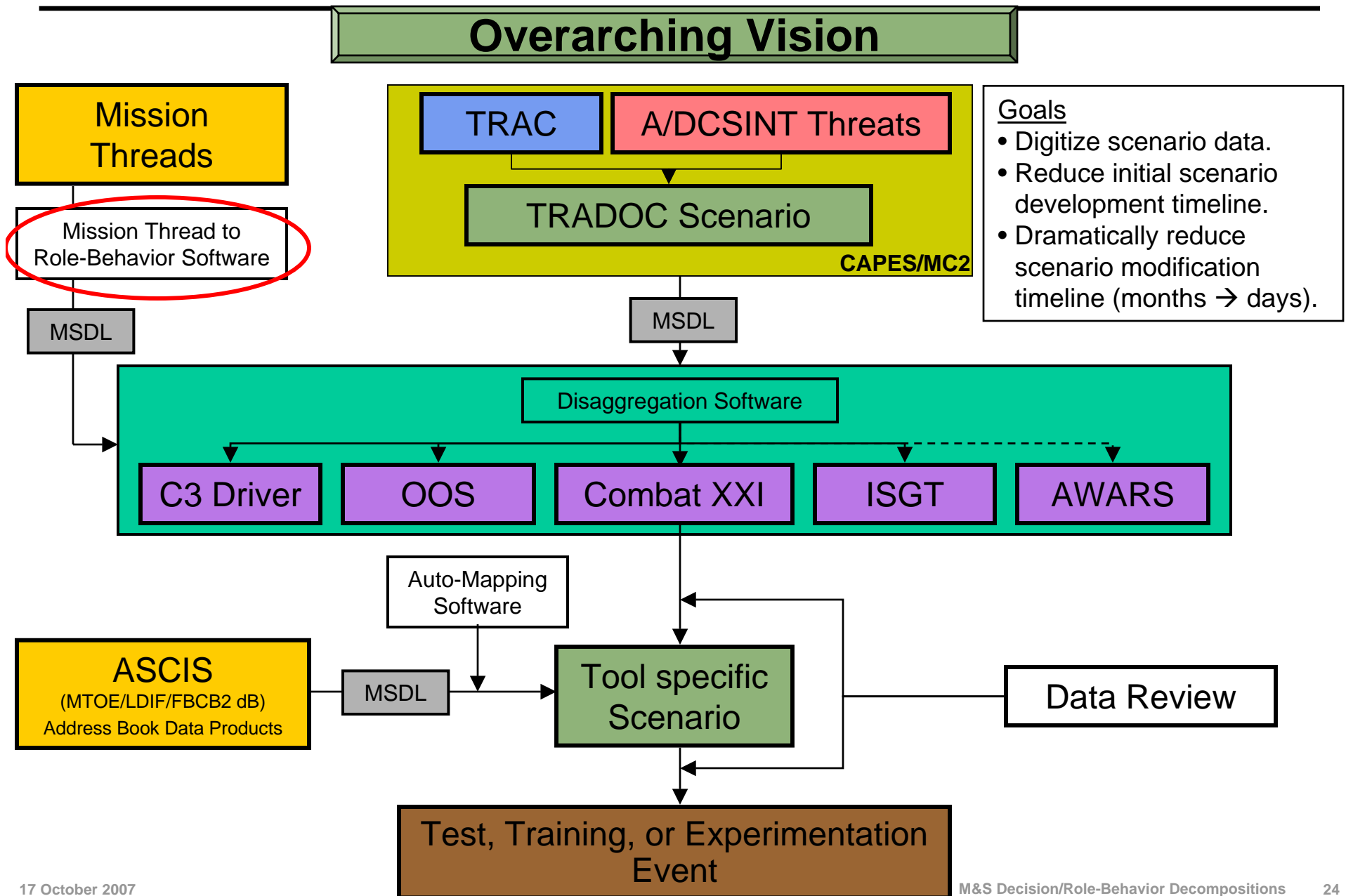


- PowerPoint feel desired
- Two formats will be implemented
  - Compressed: 1-page thread diagram
  - Full: multi-sheet diagram
- Export to html for review
- Visio/html diagram hyperlinked to Grid Entry
- All diagram objects have data behind them



# Scenario Generation Collaboration

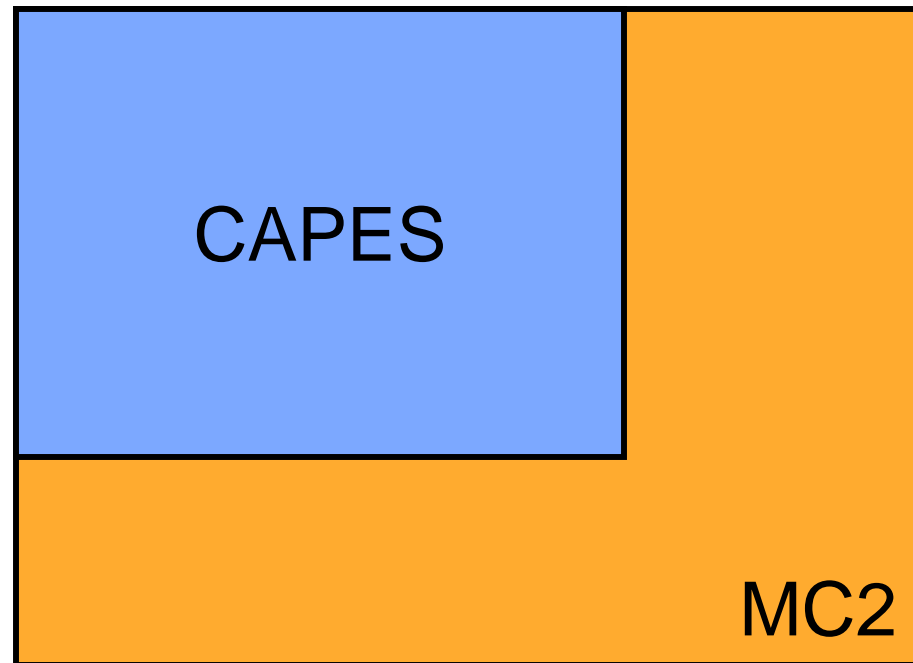
## *Rapid Scenario Generation Process*



# CAVES/MC2

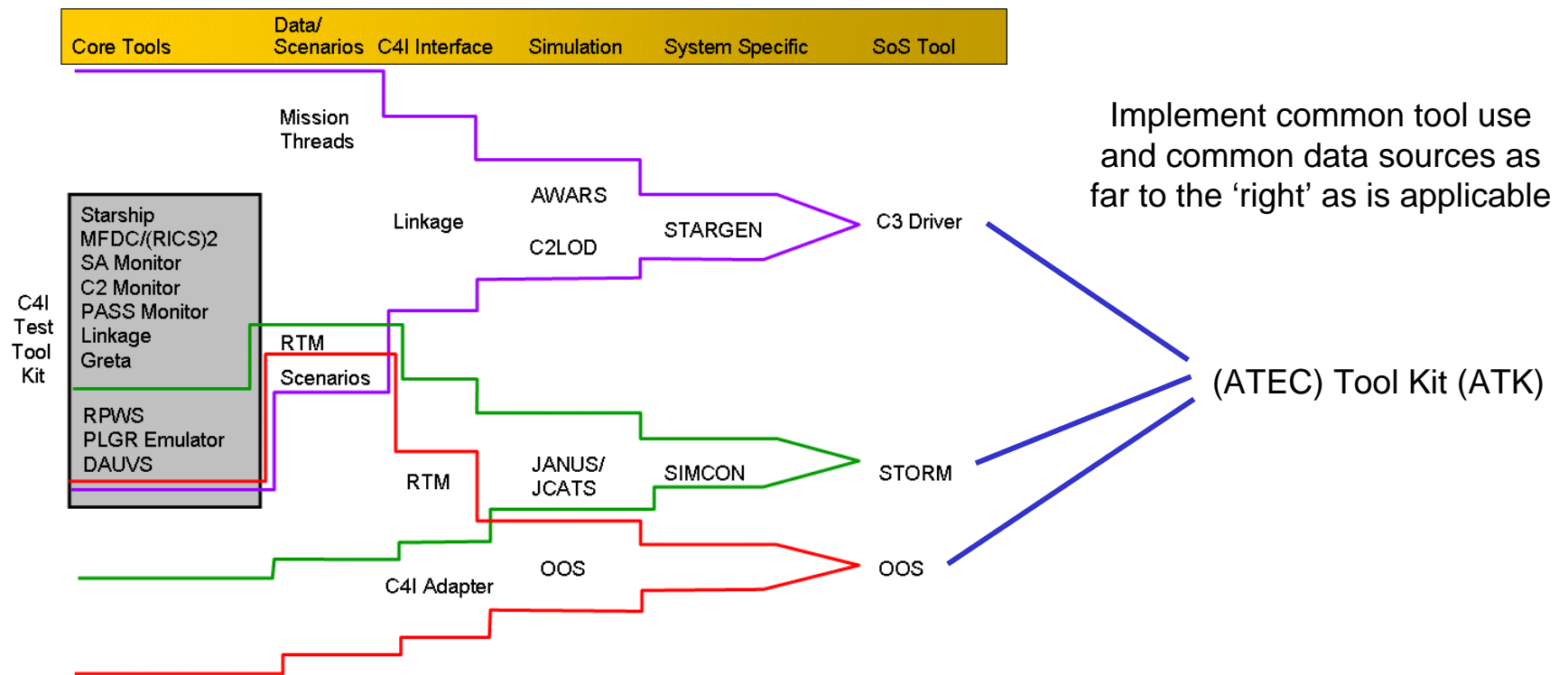
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- CAVES is the Course-of-Action (COA) tool within the Mobile Command-and-Control (MC2) system.
  - Digitally captures the COA.
- CAVES resides on all Maneuver Control System (MCS) boxes.



# Cross-Agency Collaboration

- Intra-agency/cross-command/cross-domain initiatives are underway to share the development and use of common tools, products, and processes.
  - Alleviate redundant development to free compressed resources for other tasks.
  - Streamline the Army acquisition process.
  - Support training and operations.
- Open and cooperative interactions exist and are key to continued success.



SENSING	
	Find Targets
	Examine Targets
	Examine Terrain
	Detect Environment
	Detect NBC

**Sensing**

- Find Targets
  - Detect Target
    - Sensor
      - $P_{det}(cum)$
      - $P_{det}(ss)$ 
        - Sensor Characteristics
          - $S/N \rightarrow P_{det}(SS)$
          - Tx Energy
          - Display
          - Processing
          - Sensor Type
          - Number of Tracks
          - Vigilance
          - Degradation
          - Training
          - Operator Location
          - Processing Time
          - Tx Time
        - Signal
          - Signature
            - RCS/Proj. Area
            - Frequency
            - Incident Energy
          - Noise
            - Terrain
            - Weather
            - CMs
        - Sensor (TTP)
          - Magnify
          - Gimbals
          - Scan Pattern
          - Scan Rate
          - Cue Utilization
            - Internal
            - External
            - FOV
            - Mainlobe
            - Peripheral/SL
          - Number of Tracks/Targets
          - Training
          - Sensor TTP Change Time
          - Cue Change Time
        - Aircraft
          - Stand-Off Range
          - X,Y,Z
          - V-vector
          - Range
          - Training
          - Aircraft TTP Change Time
        - Target Data
          - X,Y,Z
          - V-vector
          - Range
          - Training
          - Target Change Time
        - CMs
          - Cover/Terrain Masking
          - Concealment
          - ECM
          - Other CM
          - Training
          - CM Change/Implementation Time
      - Recognize Target
        - Sensor/Track Fusion
          - Manual Fusion
          - Automated Fusion
        - Threat Effects
          - Target Data
            - X,Y,Z
            - V-vector
            - Range
            - Training
            - Target Change Time
          - CMs
            - Cover/Terrain Masking
            - Concealment
            - ECM
            - Other CM
            - Training
            - CM Change/Implementation Time
        - Track Correlation
          - Sensor
            - Display
          - Target Data
            - X,Y,Z
            - V-vector
            - Range
            - On-Board
              - Data Content
            - Off-Board
              - Data Content
              - Tx Time
          - Data Utilization
            - Track Correlation SA Fusion
              - Processing
              - Number of Tracks
              - Training
              - Processing Time
            - Sensor Processing
              - GUI
              - Number of Tracks
              - GUI Use Time
          - Digitally Tie Tracks

Legend on Slide 35.

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